

WHAT IS CLAIMED IS:

1 1. A method for copying data to multiple remote sites, the method
2 comprising:
3 transmitting data from a first volume in a primary storage system to a back-up
4 volume provided in a secondary storage system, the primary storage system being located at a
5 primary site and the secondary storage system being located at a first remote site from the
6 primary site;
7 copying the data from the first volume in the primary storage system to a
8 second volume in the primary storage system using a point in time (PiT) as a reference point
9 of time for the copying, the second volume being provided with a first time consistent image
10 of the first volume with respect to the reference point of time; and
11 transferring the data from the second volume in the primary storage system to
12 a third volume in a ternary storage system at a second remote site, the third volume being
13 provided with a second time consistent image of the second volume, which is substantially
14 the same as the first time consistent image.

1 2. The method of claim 1, further comprising:
2 copying the data from the third volume in the ternary storage system to a
3 fourth volume in the ternary storage system, the fourth volume being provided with a third
4 time consistent image corresponding to the second time consistent image, the third time
5 consistent image being substantially the same as the first time consistent image.

1 3. The method of claim 1, wherein the transmitting step involves a
2 synchronous remote copying method, and the transferring step involves an asynchronous
3 remote copying method.

1 4. The method of claim 1, wherein the first and second time consistent
2 images are substantially the same.

1 5. The method of claim 1, further comprising:
2 receiving a plurality of data write requests at the primary storage system from
3 a primary host, each of the data write requests having a timestamp and data associated with
4 that write request; and
5 storing the data write requests in the primary storage system.

1 6. The method of claim 5, wherein the copying step includes:
2 retrieving first timestamp associated with first data; and
3 shadow copying the first data from the first volume to the second volume if
4 the first timestamp indicates a time that is prior to the reference point of time.

1 7. The method of claim 6, further comprising:
2 retrieving second timestamp associated with the second data; and
3 not copying the second data to the second volume if the second timestamp
4 indicates a time that is subsequent to the reference point of time.

1 8. The method of claim 6, further comprising:
2 suspending the copying step if all data stored in the first volume having
3 timestamps that precede the reference point of time are shadow copied to the second volume.

1 9. The method of claim 8, further comprising:
2 setting a freeze mode for the first and second volumes.

1 10. The method of claim 9, further comprising:
2 determining whether or not the first and second volumes are placed in the
3 freeze mode; and
4 checking the status of the second and third volumes to determine if the second
5 time consistent image of the second volume has been copied entirely to the third volume.

1 11. The method of claim 10, further comprising:
2 suspending the transferring step upon determining that the third volume has
3 been provided with a time consistent image corresponding to the second time consistent
4 image.

1 12. The method of claim 1, further comprising:
2 copying the data from the third volume in the ternary storage system to a
3 fourth volume in the ternary storage system, the fourth volume being provided with a third
4 time consistent image corresponding to the second time consistent image; and
5 estimating time required for providing the fourth volume with the third time
6 consistent image using information relating to the an amount of data copied from the first
7 volume to the second volume in a previous copy cycle.

1 13. The method of claim 12, wherein the amount of data corresponds to
2 the data copied to the second volume from the first volume to provide the second volume
3 with the second time consistent image.

1 14. The method of claim 12, wherein the information relating to the
2 amount of data copied from the first volume to the second volume corresponds to a copy time
3 needed to provide the second volume with the second time consistent image.

1 15. A method for copying data to a remote site, the method comprising:
2 copying data from a first volume to a second volume to provide the second
3 volume with a first time consistent image with respect to a first given time, the first and
4 second volumes being provided in a first storage system; and
5 transferring the data from second volume to a third volume to provide the third
6 volume with a second time consistent image with respect to a second given time, the third
7 volume being provided in a second storage system that is located at least 10 miles from the
8 first storage system.

1 16. The method of claim 15, further comprising:
2 transmitting the data stored in the first volume to a back-up volume provided
3 in a third storage system,
4 wherein the transmitting step involves a synchronous remote copying method
5 and the transferring step involves an asynchronous remote copying method.

1 17. The method of claim 15, further comprising:
2 receiving the data at the first storage system from a third storage system,
3 wherein the receiving step involves a synchronous remote copying method and
4 the transferring step involves an asynchronous remote copying method,
5 wherein the first and second storage systems are storage sub-systems,
6 wherein the first given time and the second given time are the same.

1 18. The method of claim 15, wherein the copying step includes copying
2 the data from the first volume to a plurality of secondary volumes to provide each of the
3 secondary volumes with the first time consistent image with respect to the first given time,
4 the first and secondary volumes being provided in the first storage system,

5 wherein the transferring step includes transferring the data from the secondary
6 volume to a plurality of ternary volumes to provide each of the ternary volumes with the
7 second time consistent image with respect to the second given time, the ternary volumes
8 being provided in a plurality of secondary storage systems that are located at least 10 miles
9 from the first storage system.

1 19. A computer system, comprising:
2 a timer to provide a timestamp to data requests;
3 an interface configured to form a communication link with a first storage sub-
4 system; and
5 a computer storage medium including:
6 code for initiating copying of data from a first volume to a second
7 volume to provide the second volume with a first time consistent image with respect to a first
8 given time, the first and second volumes being provided in a first storage sub-system, and
9 code for initiating transferring of the data from second volume to a
10 third volume to provide the third volume with a second time consistent image with respect to
11 a second given time, the third volume being provided in a second storage system that is
12 located at least 10 miles from the first storage sub-system.

1 20. The computer system of claim 19, wherein the computer system is a
2 host coupled to the first storage sub-system or a storage system including a plurality of
3 storage sub-systems provided at multiple sites.

1 21. A computer readable medium for use in a storage system, the medium
2 comprising:
3 code for copying data from a first volume to a second volume to provide the
4 second volume with a first time consistent image with respect to a first given time, the first
5 and second volumes being provided in a first storage system; and
6 code for transferring the data from second volume to a third volume to provide
7 the third volume with a second time consistent image with respect to a second given time, the
8 third volume being provided in a second storage system that is located at least 10 miles from
9 the first storage system.

1 22. The computer readable medium of claim 21, wherein the medium is
2 provided in a host or storage sub-system.

1 23. A method for copying a volume in a storage system, the method
2 comprising:
3 checking a first timestamp of a first data to be copied from a first volume to a
4 second volume;
5 copying the first data to the second volume if the first timestamp is prior to a
6 given reference point;
7 checking a second timestamp of a second data to be copied from the first
8 volume to the second volume;
9 suspending the copy operation if the second timestamp is after the reference
10 point; and
11 placing the second volume in a Freeze mode to indicate that the second
12 volume includes a point in time (PiT) copy of the first volume.

1 24. The method of claim 23, wherein the first and second volumes are
2 defined in the same storage disk array, wherein the first volume receives a write request from
3 a host while data are being copied from the first volume to the second volume.

1 25. A method for providing a point in time remote copy to a remote
2 storage system, the method comprising:
3 transmitting first and second data with the first and second timestamps from a
4 first volume in a primary storage system to a second volume provided in a secondary storage
5 system, the primary storage system being located at a primary site and the secondary storage
6 system being located at a first remote site from the primary site, the first and second time
7 stamps being associated with the first and second data, respectively;
8 copying the first data from the second volume to a third volume provided in
9 the secondary storage system using a point in time (PiT) as a reference point of time for the
10 copying; and
11 transferring the first data from the third volume in the secondary storage
12 system to a fourth volume in a ternary storage system at a second remote site,
13 wherein the copying step is suspended if the second timestamp of the second
14 data does not satisfy the reference point of time.

1 26. A method for providing a point in time remote copy, the method
2 comprising:

3 checking a first timestamp of a first data to be copied from a first volume to
4 each of second and third volumes, the first, second, and third volumes being provided in the
5 same storage system;
6 copying the first data to the second and third volumes if the first timestamp is
7 prior to a given reference point;
8 remote copying the first data from the second and third volumes to fourth and
9 fifth volumes, respectively;
10 transmitting the first data from the fourth and fifth volumes to six and seventh
11 volumes, respectively, wherein the fourth and six are provided in a first remote storage
12 system and the fifth and seventh volumes are provided in a second remote storage system;
13 checking a second timestamp of a second data to be copied from the first
14 volume to the second and third volumes; and
15 placing the second and third volumes in a Freeze mode to indicate that the
16 second volume includes a point in time (PiT) copy of the first volume if the second
17 timestamp of the second data to be copied from the first volume to the second and third
18 volumes is after the reference point.